REPORT DOCUMENTATION PAGE

Form Approved
OMB No. 0704-0188

1. AGENCY USE ONLY *(Leave blank)*	2. REPORT DATE 10/00/78	3. REPORT TYPE AND DATES COVERED

4. TITLE AND SUBTITLE
BASIN F DISPOSAL EVALUATION

5. FUNDING NUMBERS

6. AUTHOR(S)
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7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES)
CHEMICAL SYSTEMS LABORATORY (U.S.). MUNITIONS DIVISION
ABERDEEN PROVING GROUND, MD

8. PERFORMING ORGANIZATION REPORT NUMBER
81324R09

9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)

10. SPONSORING/MONITORING AGENCY REPORT NUMBER

11. SUPPLEMENTARY NOTES

12a. DISTRIBUTION/AVAILABILITY STATEMENT
APPROVED FOR PUBLIC RELEASE; DISTRIBUTION IS UNLIMITED

12b. DISTRIBUTION CODE

13. ABSTRACT *(Maximum 200 words)*

THIS DOCUMENT CONSISTS OF AN OUTLINE AND TABLE BRIEFING OF THE BASIN F EVALUATION. TOPICS REVIEWED ARE: OBJECTIVES, BACKGROUND, LITERATURE SURVEY, CONTRACTOR INFORMATION, RECOVERY ASPECTS, DISPOSAL SCENARIOS, RMA INCINERATOR EVALUATION, ENVIRONMENTAL ASPECTS, DISPOSAL COSTS, CONCLUSION AND RECOMMENDATIONS. THE OBJECTIVES ARE: (1) REVIEW TECHNICAL LITERATURE, (2) CONDUCT INTEREST SURVEY TO EVALUATE CAPABILITY AND INTEREST OF PRIVATE INDUSTRY, (3) ESTIMATE RECOVERY VALUE OF BASIN F CONTENTS, (4) IDENTIFY WASTE TREATMENT PROCESSES, (5) IDENTIFY ENVIRONMENTAL IMPACTS OF DISPOSAL, (6) RECOMMEND DISPOSAL PLAN.

14. SUBJECT TERMS	15. NUMBER OF PAGES
CHEMICALS, SEDIMENT ANALYSIS	16. PRICE CODE

17. SECURITY CLASSIFICATION OF REPORT	18. SECURITY CLASSIFICATION OF THIS PAGE	19. SECURITY CLASSIFICATION OF ABSTRACT	20. LIMITATION OF ABSTRACT
UNCLASSIFIED			

BASIN F DISPOSAL EVALUATION

BY
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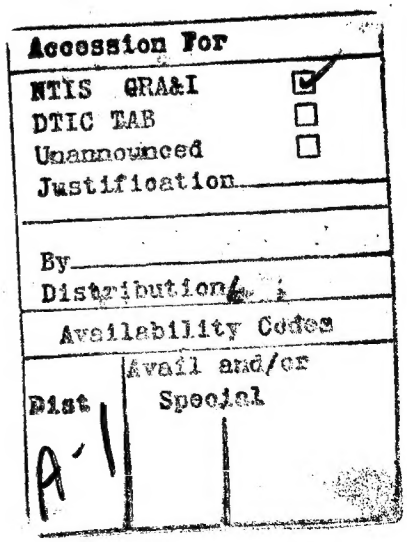
OCTOBER 1978

PROCESS TECHNOLOGY BRANCH
MUNITIONS DIVISION
CHEMICAL SYSTEMS LABORATORY

BASIN F DISPOSAL EVALUATION

BRIEFING SUBJECTS

1. OBJECTIVES
2. BACKGROUND
3. LITERATURE SURVEY
4. CONTRACTOR INFORMATION
5. RECOVERY ASPECTS
6. DISPOSAL SCENARIOS
7. RMA INCINERATOR EVALUATION
8. ENVIRONMENTAL ASPECTS
9. DISPOSAL COSTS
10. CONCLUSIONS
11. RECOMMENDATIONS



BASIN F DISPOSAL EVALUATION

OBJECTIVES

1. REVIEW TECHNICAL LITERATURE

2. CONDUCT INTEREST SURVEY TO EVALUATE CAPABILITY AND INTEREST OF PRIVATE INDUSTRY

3. ESTIMATE RECOVERY VALUE OF BASIN F CONTENTS

4. IDENTIFY WASTE TREATMENT PROCESSES

5. IDENTIFY ENVIRONMENTAL IMPACTS OF DISPOSAL

6. RECOMMEND DISPOSAL PLAN

WASTE BASIN LIQUID ANALYSIS

COMPONENT	COMPONENT ANALYSIS RANGE
	PARTS PER BILLION
ALDRIN	20 - 480
ISODRIN	<1 - 17
DIELDRIN	5 - 110
ENDRIN	5 - 42
DITHIANE	<20 - 123
	PARTS PER MILLION
DIISOPROPYLMETHYLPHOSPHONATE	6 - 55
DIMETHYLMETHYLPHOSPHONATE	320 - 3,750
P-CHLOROPHENYLMETHYLSULFOXIDE	4 - 10
P-CHLOROPHENYLMETHYLSULFONE	19 - 76
CHLORIDE	47,500 - 57,500
SULFATE	20,500 - 32,500
COPPER	709 - 760
IRON	5 - 13
NITROGEN	112 - 150
ORTHOPHOSPHATE	99 - 131
HARDNESS (AS CACO3)	2,090 - 2,850
TOTAL SOLIDS	140,000 - 174,000
FLUORIDE	110 - 117
TOTAL PHOSPHORUS	2,060 - 2,170
ARSENIC	1.0 - 1.3
MAGNESIUM	35.6 - 41.2
MERCURY	0.026 - 1.53
CYANIDE	1.44 - 1.53
COD	24,400 - 26,000
TOC	20,200 - 22,800

WASTE BASIN SEDIMENT ANALYSIS

COMPONENT	COMPONENT ANALYSIS RANGE PARTS PER MILLION
ALDRIN	16 - 10,700
ISODRIN	2 - 870
DIELDRIN	4 - 3,600
ENDRIN	2 - 1,100
DDT	<2 - 198
DIISOPROPYLMETHYLPHOSPHONATE	1 - 10
DIMETHYLMETHYLPHOSPHONATE	<1 - 82
P-CHLOROPHENYLMETHYLSULFONE	14 - 290
COPPER	230 - 21,000
IRON	190 - 11,000
TOTAL PHOSPHATE	<1 - 34,300

PROCESS EVALUATION

I. ORGANICS:
- A. STORAGE
- B. INCINERATION
- C. WET OXIDATION
- D. EVAPORATION
- E. REVERSE OSMOSIS
- F. BIOLOGICAL TREATMENT
- G. CHEMICAL DEGRADATION
- H. OZONE
- I. ADSORPTION
- J. ELECTRO-OXIDATION
- K. RADOX PROCESS

II. INORGANIC SALTS:
- A. EVAPORATION
- B. FREEZE CONCENTRATION
- C. CRYSTALLIZATION
- D. REVERSE OSMOSIS
- E. ELECTRODIALYSIS
- F. IONIC EXTRACTION
- G. IONIC ADSORPTION
- H. CHEMICAL FIXATION

III. HEAVY METALS:
- A. CHEMICAL PRECIPITATION
- B. CARBON ADSORPTION
- C. ION EXCHANGE
- D. REVERSE OSMOSIS
- E. CEMENTATION

LIQUID TREATMENT MATRIX (LITERATURE REVIEW)

Component	Carbon	Ion Exchange	Electrolytic Technology*	R.O.	Ozone*	WAO	Lime	Radox	Alumina	Biological
Aldrin	P			P	X	X		P		X
Isodrin	P			P	P	P		P		P
Dieldrin	P			P	X	X		P		P
Endrin	X			P	X	P		P		P
Dithiane	P			P	P	P		P		P
Diisopropylmethylphosphonate	X			P	X	X		P		P
Dimethylmethylphsophonate	P			P	P	X		P		P
p-chlorophenylmethylsulfoxide	X			P	X	P		P		P
p-chlorophenylmethylsulfone	X			P	X	P		P		P
Chloride	X	X	X	X						
Sulfate		X	X				X			
Copper			X		X	X	X			X
Iron		X					X			X
Nitrogen							X		X	
Orthophosphate		X					X			
Fluoride										
Total Phosphorus							X			
Arsenic	X									
Magnesium										
Cyanide		X	X		X			X		
COD						X				X
TOC					X	X				X
Mercury	X	X	X							

*Dilution required to treat Basin F material.

KEY: X = Literature indicates process can treat.
P = Author feels process probably can treat.

BASIN F INDUSTRIAL SURVEY

GENERAL TYPES OF INDUSTRIAL EXPERIENCE

I. LANDFILL DISPOSAL
   - A. BKK (WILMINGTON, CALIFORNIA)
   - B. IT ENVIRONMENTAL CORPORATION (MARTINEZ, CALIFORNIA)

II. GENERAL DISPOSAL
   - A. CHEM-TROL (MODEL CITY, NEW YORK)
   - B. DYNALECTRON CORPORATION (BETHESDA, MARYLAND)
   - C. ECOLOGY PRODUCTS (SANTA BARBARA, CALIFORNIA)
   - D. NEWCO (NIAGARA FALLS, NEW YORK)
   - E. WES-CON (TWIN FALLS, IDAHO)

III. ENGINEERING CONSULTANTS
   - A. BATTELLE (COLUMBUS, OHIO)
   - B. CATALYTIC (PHILADELPHIA, PENNSYLVANIA)
   - C. MATRIX ENGINEERS (PITTSBURGH, PENNSYLVANIA)
   - D. MB ASSOCIATES (SAN RAMON, CALIFORNIA)
   - E. STEARNS-ROGER (DENVER, COLORADO)
   - F. VERSAR, INC. (SPRINGFIELD, VIRGINIA)
   - G. ZIMPRO (ROTHSCHILD, WISCONSIN)

BASIN F INDUSTRIAL SURVEY

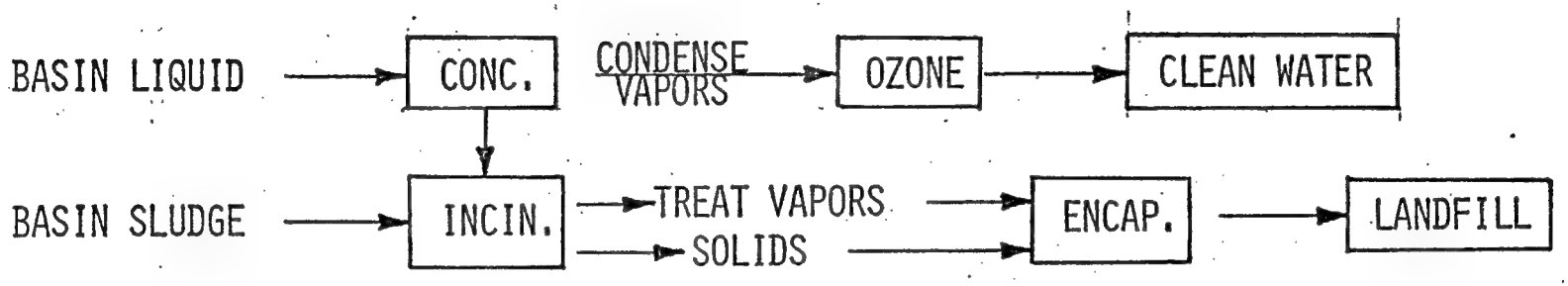
TYPES OF PROCESSES REGARDED AS HAVING POTENTIAL BY INDUSTRY

COMPANY	CONCENTRATION OR EVAPORATION	WET AIR OXIDATION	CARBON ADSORPTION	SOLVENT EXTRACTION	BIODEGRADATION	ION EXCHANGE	NEUTRALIZATION	METAL PRECIPITATION	RECOVERY TECHNOLOGIES	REJECTED RECOVERY	INCINERATION	PYROLYSIS	FIXATION	
BATELLE	X		X			X		X		X	X	X		
BKK						X			X		X		X	
CATALYTIC	X		X	X					X		X		X	
DYNALECTRON CORP.											X			
ECOLOGY PRODUCTS												X	X	
IT ENVIRONMENTAL CORP.	X									X	X			
MATRIX ENGINEERS	X									X			X	
MB ASSOCIATES	X										X			
NEWCO	X										X		X	
STEARNS-ROGER	X				X		X			X	X			
VERSAR, INC.											X			
WES-CON											X			
ZIMPRO		X	X					X					X	
TOTAL OUT OF 13	7	1	3	1	1	2	1	2	2	4	10	2	6	7
PERCENTAGE (%)	54	8	23	8	8	15	8	15	15	31	77	15	46	5

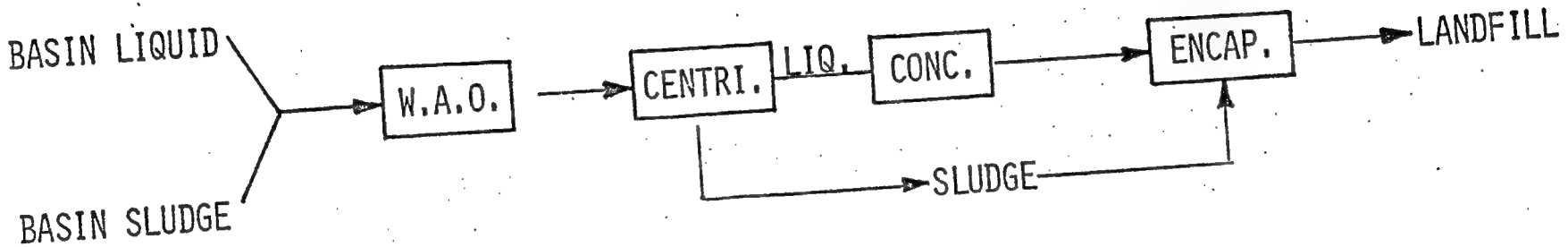
BASIN F RECOVERY VALUE

COMPONENT	MARKET PRICE	VALUE
ALUMINUM (BASIN LIQUID)	$ 0.53/LB	$ 316
CADMIUM (BASIN LIQUID)	$ 2.25/LB	$ 128,311
CHROMIUM OXIDE (BASIN LIQUID)	$ 0.96/LB	$ 162
COBALT OXIDE (BASIN LIQUID)	$ 5.93/LB	$ 6,243
COPPER (BASIN LIQUID)	$ 0.60/LB	$ 595,527
COPPER (BASIN SEDIMENT)	$ 0.60/LB	$1,073,400
IRON OXIDE (BASIN LIQUID)	$ 0.36/LB	$ 3,771
LEAD DIOXIDE (BASIN LIQUID)	$ 0.66/LB	$ 43
MAGNESIUM (BASIN LIQUID)	$ 0.99/LB	$ 51,080
MANGANESE DIOXIDE (BASIN LIQUID)	$ 0.08/LB	$ 128
MERCURY (BASIN LIQUID)	$ 3.97/LB	$ 146
NICKEL (BASIN LIQUID)	$ 2.11/LB	$ 16,044
SILVER (BASIN LIQUID)	$70.25/LB	$ 5,844
ZINC (BASIN LIQUID)	$ 0.29/LB	$ 512
	TOTAL	$1,881,527

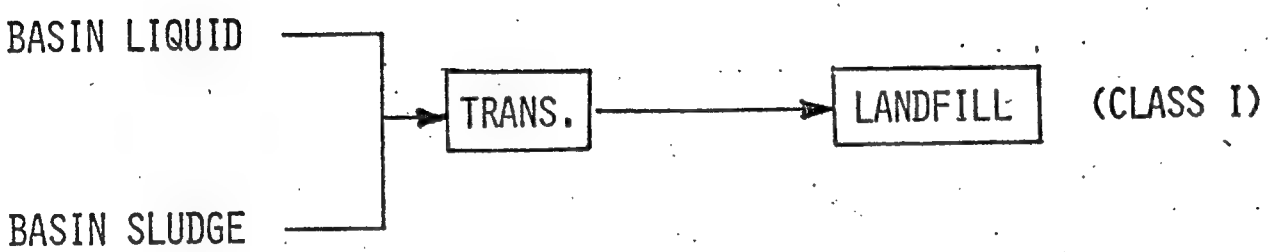
SCENARIO #1


BASIN LIQUID
CONC.
CONDENSE VAPORS
OZONE
CLEAN WATER
BASIN SLUDGE
INCIN.
TREAT VAPORS
SOLIDS
ENCAP.
LANDFILL

SCENARIO #2


BASIN LIQUID
BASIN SLUDGE
W.A.O.
CENTRI.
LIQ.
CONC.
ENCAP.
LANDFILL
SLUDGE

SCENARIO #3



SCENARIO #4

SCENARIO #5

BASIN F CONTROL

SCENARIO #6

Dull report-81336 R19

EVALUATION OF THE ROCKY MOUNTAIN ARSENAL INCINERATORS FOR USE IN BASIN F DISPOSAL SCENARIOS

BY

HERMAN F. HILDEBRANDT

OBJECTIVE

TO EVALUATE THE POSSIBILITY OF USING EXISTING ROCKY MOUNTAIN ARSENAL INCINERATORS IN THE DISPOSAL SCENARIOS DEVELOPED AS PART OF THE BASIN F DISPOSAL EVALUATION.

MATERIAL TO BE PROCESSED - DRY BASIS

SCENARIOS 1, 4, 5 - 306,800 TONS

SCENARIO 6 - 45,350 TONS

OPERATING PERIOD - 4 YEARS

REQUIRED FEED RATES - DRY BASIS

SCENARIOS 1, 4, 5 - 10.65 TONS/HR

SCENARIO 6 - 1.6 TONS/HR

INCINERATOR SYSTEM CRITERIA

1. PRIMARY COMBUSTION AT 1500°F FOR 0.5 SEC.

2. ONE HOUR RESIDENCE TIME FOR SOLIDS.

3. AFTERBURNER TEMPERATURE OF 2000°F WITH A 2 SECOND RESIDENCE TIME.

4. MIXING OF SOLIDS DURING INCINERATION.

5. CONTINUOUS THROUGHPUT OF MATERIAL.

RMA INCINERATORS VS. BASIN F
DISPOSAL INCINERATION REQUIREMENTS

	1500°F PRIMARY COMBUSTION TEMPERATURE	ONE HOUR SOLIDS RESIDENCE TIME	DESIGNED FOR CONTINUOUS THROUGHPUT	SOLIDS MIXING DURING INCINERATION	EQUIPPED WITH AFTERBURNER	2000°F AFTERBURNER	ADEQUATE CAPACITY FOR 4 YEAR SCENARIOS
M34 FACILITY							
DEACT FURNACE	X	X	X	X			
DECON FURNACE NORTH	X		X				
DECON FURNACE SOUTH	X		X				
HONEST JOHN							
DEACT FURNACE	X	X(?)	X	X	X		
DECON FURNACE	X	X					
MUSTARD FACILITY							
BULK AGENT FURNACE	X						
TC FURNACE EAST	X	X			X		
TC FURNACE WEST	X	X					

TIME TO INCINERATE, YEARS
USING BOTH RMA ROTARY KILN INCINERATORS

SCENARIO	1, 4, OR 5	6
TOTAL TONS OF FEED (WET BASIS)	561,000[1]	252,000
TOTAL TONS OF FEED (DRY BASIS)	306,800	45,350
MOISTURE CONTENT OF WET FEED, %	45	82
YEARS TO INCINERATE (AFTERBURNER RESIDENCE LIMITING)	22[2](27)	17
YEARS TO INCINERATE (SOLIDS RESIDENCE LIMITING)[3]	27	4

[1]ASSUMES 75% OF THE BASIN F WATER HAS BEEN EVAPORATED.

[2]FOR THIS FEED MATERIAL THE THROUGHPUT IS LIMITED BY THE SOLIDS RESIDENCE TIME REQUIREMENT.

[3]ASSUMES MOISTURE CONTENT OF FEED HAS BEEN REDUCED TO 20% OR LESS BEFORE INCINERATION.

CONCLUSIONS

1. THE RMA INCINERATION CAPACITY IS INADEQUATE TO MEET THE INCINERATION REQUIREMENTS OF DISPOSAL SCENARIOS 1, 4, AND 5.

2. ONLY THE TWO ROTARY KILN DEACTIVATION FURNACES ARE SUITABLE FOR INCINERATION OF BASIN F SLUDGE.

3. THE HONEST JOHN INCINERATION SYSTEM WOULD BE AN EXCELLENT PILOT FACILITY FOR STUDYING INCINERATION OF BASIN F SLUDGE.

4. IF COMMERCIAL INCINERATION EQUIPMENT IS PURCHASED FOR BASIN F SLUDGE DISPOSAL, A ROTARY KILN TYPE SHOULD BE SELECTED.

5. THE TWO RMA ROTARY KILN FURNACES COULD INCINERATE THE SOLIDS OF SCENARIO 6 IN APPROXIMATELY 4 YEARS.

RECOMMENDATIONS

1. IT IS RECOMMENDED THAT BASIN F SLUDGE INCINERATION PARAMETERS BE DETERMINED USING THE HONEST JOHN FACILITY FOR PILOT STUDIES.

2. A ROTARY KILN INCINERATOR SHOULD BE USED FOR THE INCINERATION OF BASIN F SLUDGE IN DISPOSAL SCENARIOS 1, 4, AND 5.

3. IF SCENARIO 6 IS SELECTED, THE POSSIBILITY OF INCINERATING THE BASIN F LIQUID WITHOUT PRETREATMENT IN A VERTICALLY FIRED LIQUID WASTE INCINERATOR SHOULD BE TESTED.

4. WHEN THE PILOT STUDIES IN RECOMMENDATION 1 HAVE BEEN CONDUCTED, THE DESIRABILITY OF USING THE TWO RMA ROTARY KILN FURNACES FOR THE SCENARIO 6 INCINERATION TASK SHOULD BE DETERMINED.

STATUTES REVIEWED

- FEDERAL LAWS
  - CLEAN AIR ACT
  - FEDERAL WATER POLLUTION CONTROL ACT
  - FEDERAL DRINKING WATER ACT
  - RESOURCE CONSERVATION AND RECOVERY ACT

- STATE OF COLORADO LAWS
  - COLORADO AIR POLLUTION CONTROL ACT OF 1970
  - COLORADO WATER QUALITY CONTROL ACT
  - COLORADO SOLID WASTE DISPOSAL SITES AND FACILITIES LAW

POTENTIAL ENVIRONMENTAL PROBLEMS

- o EMISSION OF TOXIC OR HAZARDOUS SUBSTANCES TO THE ATMOSPHERE
  - ADVERSE HEALTH EFFECTS
- o CONTAMINATION OF SURFACE OR GROUNDWATER
  - DRINKING WATER
  - IRRIGATION WATER

INFORMATION REQUIREMENTS FOR PERMITS

- QUALITY AND QUANTITY OF EMISSIONS AND DISCHARGES
  - POLLUTANTS EMITTED
  - POLLUTANT CONCENTRATION
  - FLOW RATES
- ENGINEERING SPECIFICATIONS
  - WASTE STREAM RATES
  - OPERATING DESIGN CAPACITY
  - TREATMENT REQUIREMENTS
  - EMISSION CONTROL EQUIPMENT SPECIFICATIONS
- CHEMICAL AND PHYSICAL PROPERTIES
  - VOLATILITY
  - REACTIVITY
  - TOXICITY
  - PERSISTANCE
  - COMBUSTIBILITY
- HEALTH EFFECTS
  - THRESHOLD LIMIT VALUES

EXAMPLES OF OTHER INFORMATION REQUIREMENTS

- DESIGN ENGINEERING
  - QUALITY AND QUANTITY OF EMISSIONS
  - CHEMICAL AND PHYSICAL PROPERTIES
  - CORROSIVITY AND COMPATIBILITY OF CHEMICAL SUBSTANCES
  - PROCESS METHODS
  - COMPATIBILITY OF CHEMICAL SUBSTANCES WITH MATERIALS OF CONSTRUCTION
  - PROCESS EFFICIENCIES

BASIN F DISPOSAL EVALUATION

SUMMARY OF SCENARIO INFORMATION

(BASIS: FY 78 CONSTANT DOLLARS)

A. MINIMUM LEAKAGE SIX INCHES BELOW LINER:

SCENARIO	ESTIMATED TIME (YEARS)	ESTIMATED COST ($MILLIONS)
#1 CONC. - INCIN.	7	36.9
#2 W.A.O.*	7	35.6
#3 TRANSPORTATION	5	70.9
#4 EVAP. - ENCAP.	9	30.1
#5 EVAP. - LANDFILL	9	20.6
#6 CONTAINMENT - EVAP. - FILL-IN	10	12.6

B. LEAKAGE SIX FEET BELOW LINER:

SCENARIO	ESTIMATED TIME (YEARS)	ESTIMATED COST ($MILLIONS)
#1 CONC. - INCIN.	14	87.7
#2 W.A.O.*	14	82.7
#3 TRANSPORTATION	9	125.9
#4 EVAP. - ENCAP.	14	76.7
#5 EVAP. - LANDFILL	14	48.4
#6 CONTAINMENT - EVAP. - FILL-IN	10	12.6

*WET-AIR-OXIDATION

TABLE C

BASIN F DISPOSAL EVALUATION
SUMMARY OF SCENARIO INFORMATION*

(Basis: Inflated Dollars Over Project Years)

A. MINIMUM LEAKAGE (SIX INCHES BELOW LINER):

SCENARIO	ESTIMATED TIME (Years)	ESTIMATED COSTS ($ Millions)
#1 Conc. - Incin. - Encap. - Landfill	7	45.7
#2 W.A.O.** - Encap. - Landfill	7	43.8
#3 Transportation	5	84.8
#4 Evap. - Encap. - Landfill	9	42.1
#5 Evap. - Landfill	9	28.5
#6 Containment - Evap. - Fill-In	10	16.7

B. LEAKAGE SIX FEET BELOW LINER:

SCENARIO	ESTIMATED TIME (Years)	ESTIMATED COSTS ($ Millions)
#1 Conc. - Incin. - Encap. - Landfill	14	128.9
#2 W.A.O.** - Encap. - Landfil	14	116.0
#3 Transportation	9	169.2
#4 Evap. - Encap. - Landfill	14	120.0
#5 Evap. - Landfill	14	72.4
#6 Containment - Evap. - Fill-In	10	16.8

*Includes time and cost for process development work, process construction, process operation and shutdown and labor.

**Wet-Air-Oxidation

BASIN F DISPOSAL EVALUATION

LEAKAGE SIX FEET BELOW LINER

(Basis: FY 78 Constant Dollars)

SCENARIO	ESTIMATED TIME (YEARS)	ESTIMATED COSTS ($ MILLIONS)
#1 CONC. - INCIN.	14	56.8 - 87.7
#2 W.A.O.	14	55.0 - 82.7
#3 TRANSPORTATION	9	125.9
#4 EVAP. - ENCAP.	14	51.5 - 76.7
#5 EVAP. - LANDFILL	14	41.7 - 48.4
#6 CONTAINMENT - EVAP. - FILL-IN	10	8.8 - 12.6

CONTAMINANT ISOLATION SCENARIO

A. ADVANTAGES:

1. LOWER COSTS COMPARED TO THE DISPOSAL OPTIONS DISCUSSED BY THE BASIN F DISPOSAL EVALUATION STUDY.

2. AMOUNT OF SOIL CONTAMINATION UNDER BASIN F HAS NO IMPACT UPON COSTS.

3. BASIN F CONTAMINANTS WILL BE CONTAINED AND REMAIN IMMOBILE PROVIDING WATER DOES NOT RE-ENTER THE ISOLATED SYSTEM.

4. MATERIAL HANDLING OF BASIN F WASTE IS AVOIDED.

B. DISADVANTAGES:

1. THE HAZARDOUS ORGANIC WASTES ARE NOT DESTROYED.

2. THE POTENTIAL OF FUTURE MIGRATION EXISTS SINCE THE INDEFINITE LIFE OF THE CLAY BARRIER CANNOT BE GUARANTEED.

BASIN F DISPOSAL EVALUATION

CONCLUSIONS

1. INDUSTRY IS INTERESTED IN DISPOSAL OF BASIN F.

2. NECESSARY TECHNOLOGY AND CAPABILITY EXISTS.

3. RECOVERY IS NOT ECONOMICAL.

4. AMOUNT OF CONTAMINATED SOIL UNDER BASIN LINER HAS A SIGNIFICANT IMPACT ON DISPOSAL COSTS (WITH EXCEPTION OF SCENARIO #6).

5. SCENARIOS #1 - 5 DISPOSAL OPTIONS ARE NOT ECONOMICALLY JUSTIFIABLE.

6. SCENARIO #6 IS MOST COST EFFECTIVE CONTROL OPTION IDENTIFIED.

BASIN F DISPOSAL EVALUATION

RECOMMENDATIONS

1. BASIN F DISPOSAL OPTIONS SHOULD NOT BE CONSIDERED FURTHER.

2. "CONTAMINANT ISOLATION SCENARIO" (SCENARIO #6) SHOULD BE IMPLEMENTED AT BASIN F, ROCKY MOUNTAIN ARSENAL.

3. ASSESSMENT OF ENHANCED EVAPORATION TECHNOLOGY.

4. ASSESSMENT OF INCINERATION ASPECTS TO CONCENTRATE LIQUID.

5. EVALUATE NEED FOR TREATMENT OF GROUNDWATER FROM DEWATERING WELLS